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ABSTRACT

Presented are problems encountered in science teacher education and their possible solutions. Neglect of the synthetic character of science is described as a weakness. Behaviorism is thought of as serving only the function of discipline-oriented curricula. Difficulties with teacher preparation result from a lack of awareness of the cultural need served by education. A science teacher has the responsibility of helping the students develop the plasticity and adaptability to fulfill their function in the society of tomorrow. Science teacher education should emphasize: (1) the human qualities, such as freedom, choice, self-evaluation, and self-realization, essential for self-actualization, (2) the analytic and synthetic nature and the self-correcting attributes of science, and (3) the understanding of science as a cultural product. The author recommends the use of integrated approaches to interpret science with humanistic concerns. (CC)

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As the era of the national curriculum movement winds down into a lack-luster period we find fewer and fewer pre-service teacher education programs emphasizing the discipline centered curricula. We will, in the next few years, continue to see earnest and not so earnest attempts at implementing these curricula in their varying stages of metamorphosis. The current implementation thrust of the National Science Foundation's Education Division will see to that. But let us look beyond the late 70's and look to the future. Keep in mind that the teacher of science graduating this year has a career potential reaching well past the turn of the century.

With his usual perspicacity Dr. Hurd has discussed the future of the science teacher based upon, 1) the tremendous changes in American society and 2) the structure and function of science in a technological culture. The concept he has developed of the science teacher as an interpreter of science is of particular significance. The discipline-oriented programs, with their quantitative methods typical of the 1960's, were dependent on teachers with training in the analytic aspects of science. Those of you familiar with the philosophy of science realize that one of the ambiguities of science is that, "it is not only analytic; it has a synthetic character as well."[1] It is this latter component discipline-oriented programs have neglected. It is this aspect of science the interpreter of science must blend with the emerging concern for the individual as a person and social being. It is then that science may again be a significant social process.

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[1]Cohen, Robert S. "Individuality and Common Purpose: The Philosophy of Science," Boston University, mimeo.

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To be an interpreter one must be well versed in the substance being interpreted but also must know the individual(s) for whom the interpretation is being done. It would be invaluable to know the qualities of the student of the 80's; the level of sophistication, the degree of anxiety and threshold of interest. To prepare the interpreter of science, who himself is constantly growing and maturing, for a role of interpreting to a group we know nothing about is difficult to say the very least. Perhaps we can take a key from the evolutionary biology.

The species with the greatest probability of survival is the one with a balance between plasticity (the ability to accommodate to future environments) and adaptation (the ability to accommodate to the present environment). Those who have highly specialized adaptations just don't make it. We have seen what happens to the engineer specialized for a particular position. The curriculum of the 60's designed to produce better students of specific disciplines had similar inadequacies and probabilities of extinction. There wasn't a balance between the synthetic and analytic qualities of science.

If we look at current changes in science education for signs of evolutionary trends one of the most prominent is the humanistic movement and its concern for the welfare of mankind and human values. If we agree with Bronowski[2] that science is based on human values and is itself a value system, then it follows that we as science educators must reflect such systems of values. Education in science is the logical approach to clarify the role of human values such as basic needs, bias and neurosis in the so-called objectiveness of science. The interpreter of science must be equipped to do this.

Science is an important avenue to knowledge of reality. Reality is not only physical or natural but also psychological and social. If the neurotic

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[2]Bronowski, J. Science and Human Values, Harper and Row, New York, 1956.

individual distorts reality perhaps it is a result of an inability to use his skills in science? Perhaps this is an area of science education that has until now been neglected. Perhaps the humanistic psychology movement in our profession is a sign, to be heeded.

In recent years the concern for the experiencing individual has grown enormously. The individual's qualities of living, choice, self-actualization and creativity are of deep concern to some. "Consciousness III" as Charles Reich called it is drawn largely from the upper middle class, the Bohemians, the artists and the media. Many science education departments, particularly the graduate students, have long discussions of humanism vs. science. Such dialogue is reminiscent of the debates over process and product or inquiry vs. content.

I believe the concerns of the "third force" have evolved to fill the niche temporarily occupied by the behaviorism movement of the 1960's. Behaviorism does not have the balance between plasticity and adaptability to survive. Behaviorism does serve a useful function in discipline-oriented curricula; however, it is contrary to the essence of science and a culture which emphasizes freedom of choice and individual fulfillment.

It is not only in education that the late Abraham Maslow is having an effect. A recent issue of U.S. News and World Report published an interview with Herman Kahn, who is considered to be a leading authority on natural trends. His discussion ranged from economics, to draft dodgers, to the challenge of the dollar but tucked away in one section was the following:

> "...I think the traditional Americans will maintain the full list of Maslow's values for a long time, but there will be a shift more and more toward self-actualization."[3]

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[3] "How Peace Will Change Life in America: Interview with Herman Kahn." U.S. News and World Report, March 12, 1973, p. 42.

What this means to the culture as a whole I cannot say. For what it means to science education and science teacher preparation let us look to Maslow himself.

Maslow has suggested that "Science can be a path to the greatest fulfillment and self-actualization of man."[4] The self-correcting nature of science lends itself well to this premise. This leader in humanistic psychology suggests that science can be a vehicle to help the students of the present and future develop the self-concept essential for self-actualization. Based upon this interrelatedness of science and humanism we can develop several points relevant to science teacher education.

If you will accept that self-actualization or the constant striving toward the fulfillment of potential is one of man's higher needs, then can we not use this for purposes of self-renewal in the teaching profession. The Humanist suggests that the gratification of lower, more basic needs must occur prior to self-actualization. But let us make the questionable assumption that our science interpreters, as well as you and I, have these lower needs fulfilled. Such persons should be able to self-evaluate and direct their potential to focus on changes in their environment. Whether such changes are in professional careers, innovative curricula or a new psychology of learning, the self-actualizing person has the plasticity to accommodate to change. He will be able to identify his weaknesses and instigate corrective measures. The science teacher, the interpreter of science, will be self-correcting. As changes occur in society, changes in the student population or whatever, the self-actualizing interpreter of science will be able to interpret in a relevant manner. His understanding of the nature of science in the newly evolved society will be meaningful.

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[4]Maslow, Abraham. "Science and Self Actualization." The Manas Reader. Grossman Publishers, New York, 1971, p. 94.

But, you might say, we don't have self-actualizing science teachers which fit this description. My response would be that: 1) we have not emphasized in our programs the human qualities such as choice, self-evaluation and self-realization which are basic to self-actualization; 2) we have not made clear the nature of science with its ambiguities such as being synthetic while analytic or its self-correcting attributes; 3) we have not shown science as a product of culture and cultural evolution.

Gone are the days when any discipline could be taught for its own sake. The current move to unified science or integrated science and mathematics programs reflects the need by students for the applied synthesis of concepts and constructs of the sciences. A related trend is the comprehensive problem-solving approach and the material being developed by the Education Development Center (EDC).[5] The synthetic as well as the analytic nature of science are represented in such materials. I view these as attempts at responses to the demand that we make science more meaningful (humanize) to a broader portion of the public. Are our science teacher programs reflecting these trends? Will rigorous majors tempered with teacher training modules based on behavior objectives result in interpreters of science with humanistic concerns? Are we doing anything to help the future interpreters of science develop self-concepts with sufficient plasticity to work in teams and function as a part of a <u>science</u> program rather than as pseudobiologists and junior physicists?

The student of tomorrow will probably not be much different from the student of today. The perennial questions such as Who am I? Where am I going? What is my place in this Universe? will continue to be asked. Such

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[5] Unified Science and Mathematics for Elementary Schools (USMES) Education Development Center, 55 Chapel Street, Newton, MA 02160.

questions are characteristic of the human enterprise. Will our future interpreters of science be better equipped to help young people optimize answers to such questions? Will the study of science be a path to the greatest fulfillment of the potential of these future citizens? John Dewey apparently thought so when he wrote:

> One of the only two articles that remain in my creed of life is that the future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind; and that the problem of problems in our education is therefore to discover how to mature and make effective this scientific habit.[6]

The interpreter of science must have a knowledge of the role of science in society and in his own life. The most efficient manner for science educators to develop as a self-actuzlizing individual is probably through incorporating a scientific habit in his own life style. Then and only then will they, we, be able to function as interpreters of science and help our young work towards the development of their full potential.

In summary let me say that it is clear to me that many of the problems in science teacher education stem from: 1) our neglect of the human qualities and, 2) our treatment of science as separate disciplines. Our difficulties with inservice education are a combination of inappropriate preservice education and a lack of awareness of the cultural needs served by education. Science can be a path to the greatest fulfillment and self-actualization of man if we do not perpetuate programs which intentionally and arbitrarily discriminate against the characteristics of choice, freedom, and humanism. The longer our science teacher programs emphasize a behaviorialistic approach to the exclusion of humanistic concerns the greater the probability the science interpreter of the future will have neither the plasticity nor the adaptability to fulfill his vital function in the society of tomorrow.

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[6] Dewey, John. "Science as Subject Matter and as Method." Reprinted in John Dewey on Education. The Modern Library, New York, 1964, p. 191.